9.0 ENVIRONMENTAL INDICATORS OF PROGRESS

The efficacy of our efforts to reduce GLBTS level 1 and 2 substances is ultimately measured by corresponding trends of levels of these substances in the environment. This section presents monitoring data for environmental indicators in the air over the Great Lakes and in Great Lakes fish, gull eggs, and sediment. Trends in atmospheric concentrations are described by ambient air monitoring data collected by the Integrated Atmospheric Deposition Network (IADN), the National Air Pollution Surveillance (NAPS) network, the Canadian Atmospheric Mercury Measurement Network (CAMNet), the Mercury Deposition Network (MDN), and the National Dioxin Air Monitoring Network (NDAMN). Levels in fish tissue are illustrated by data collected from the Great Lakes Laboratory for Fisheries & Aquatic Sciences, Department of Fisheries & Oceans, and US EPA's Great Lakes Fish Monitoring Program. Progress evidenced in Great Lakes herring gull eggs is described by data collected through the Canadian Wildlife Service Herring Gull Egg Monitoring Program. Spatial and temporal trends in Great Lakes sediment are indicated by data collected from various water and sediment contaminant monitoring programs operating in the Great Lakes.

Trends in Ambient Air

Ambient Air Monitoring of Great Lakes Toxics
Submitted by Todd Nettesheim, Region 5 US EPA

Integrated Atmospheric Deposition Network (IADN)

The Integrated Atmospheric Deposition Network (IADN) is a joint United States-Canada atmospheric monitoring network that has been in operation since 1990. The IADN consists of five master stations, one near each of the Great Lakes, and several satellite stations. Concentrations of PCBs, pesticides, polycyclic aromatic hydrocarbons (PAHs), and trace metals are measured in ambient air, suspended particles, and precipitation at each station. These data are used to estimate the spatial and temporal trends of toxic contaminants in air and precipitation and loadings to the Great Lakes.

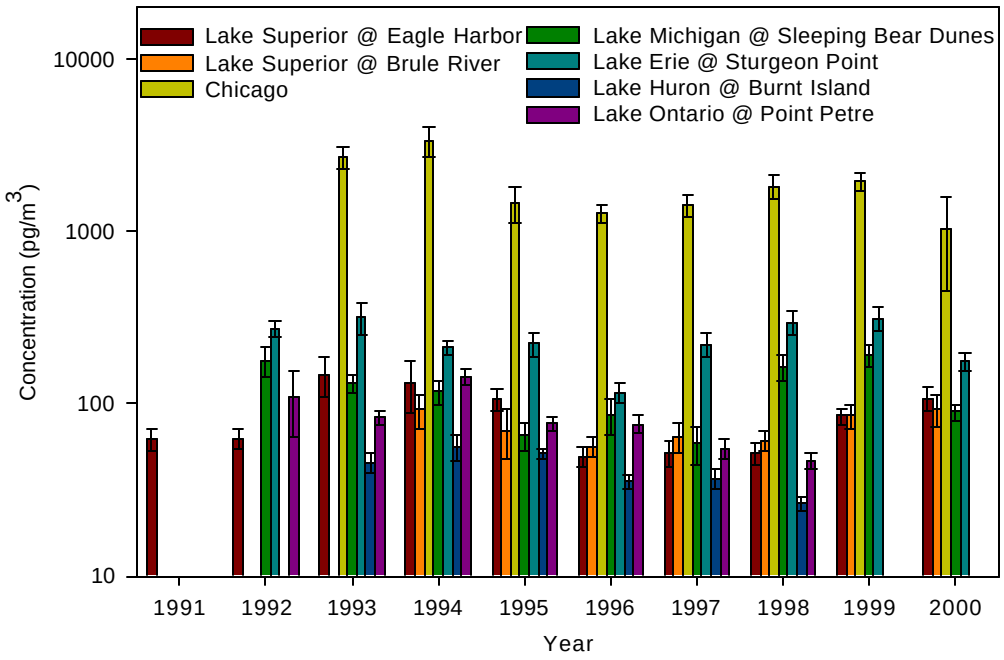

Figure 9-A1. Annual Average Atmospheric Gas-phase Total PCB Concentrations

Figure 9-A1 illustrates that there has generally been a decline in total PCB concentrations in the air near each of the Great Lakes over the past 10 years. A review of pre-1990 PCB data collected near Lakes Superior and Michigan from the literature further supports the notion that total PCB concentrations are declining and approaching equilibrium around the Great Lakes (see Figure 9-A2). Data from more recent years (1997-1999) suggest a change to this trend; however, data from 2000 and 2001 (preliminary) show a decrease in PCB concentrations. It is assumed that PCB concentrations will continue to decrease slowly.

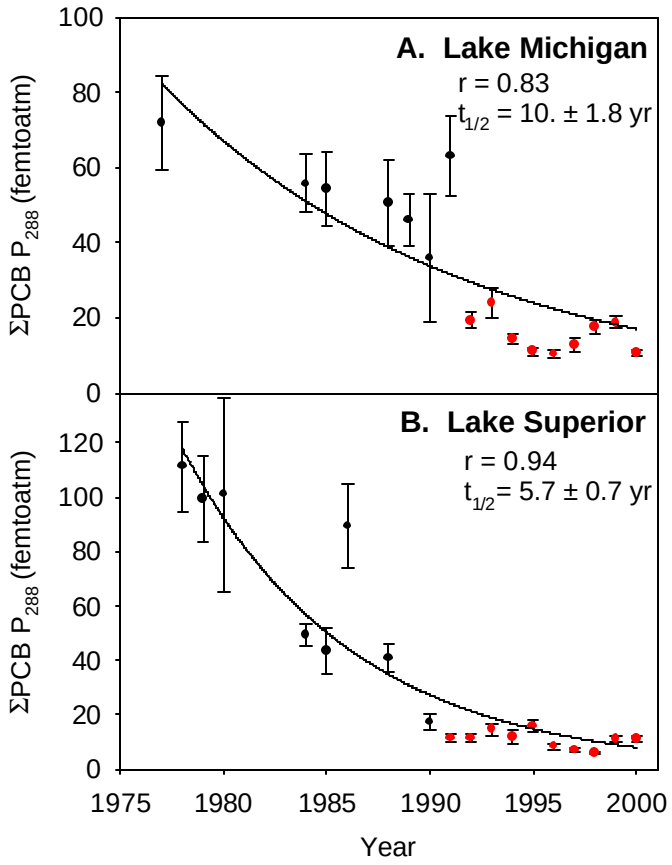

Figure 9-A2. Long-term PCB Concentrations

Figure 9-A1 also clearly illustrates the spatial variations of gas-phase total PCB concentrations in air near the Great Lakes. Note the logarithmic scale for concentrations in Figure 9-A1, which shows that total PCB concentrations at the Chicago satellite station have been about an order of magnitude higher than at all the other sites. It is expected that PCB concentrations should be elevated in the Chicago urban area because of the widespread use of PCBs in industrial applications in the middle of the 20th century. However, the IADN also measures an "urban effect" on the PCB concentrations at the Sturgeon Point master station, which is approximately 20 kilometers southwest of the Buffalo urban area. Furthermore, recent research is revealing that the influence of the Chicago urban area may reach as far away as Lake Superior.

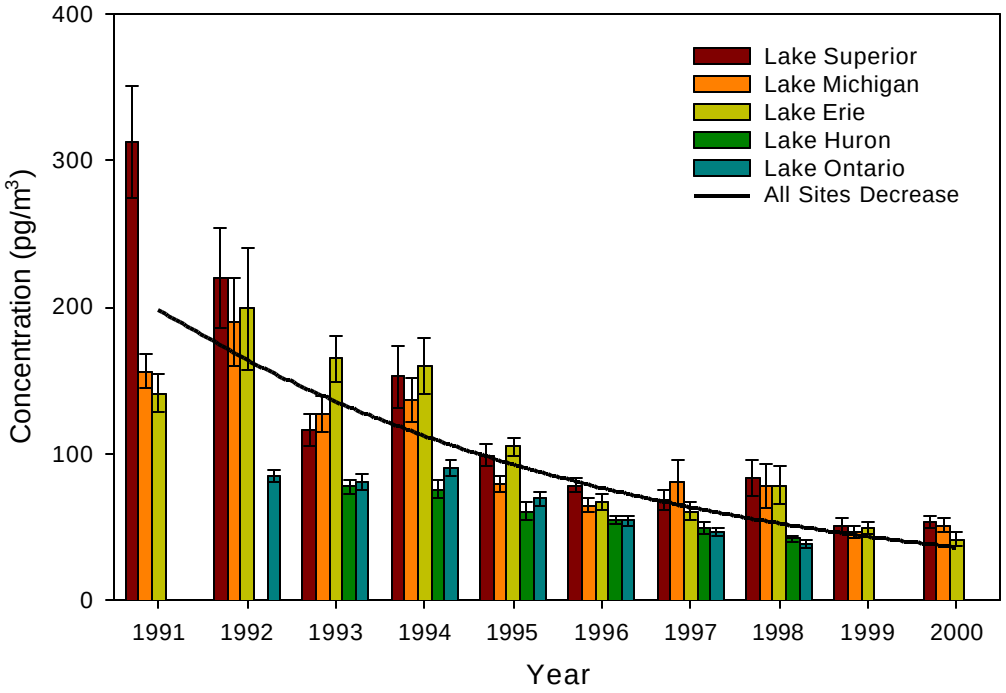

Figure 9-A3. Annual Average Atmospheric Gas-phase a-HCH Concentrations

Gas-phase a-hexachlorcyclohexane (HCH) concentrations are also decreasing at IADN stations (see Figure 9-A3). This declining trend also correlates well with declining global use trends of a-HCH. This downward trend is, in general, the case for the other banned or restricted pesticides measured by IADN. Concentrations of organochlorine pesticides in precipitation have also decreased over time.

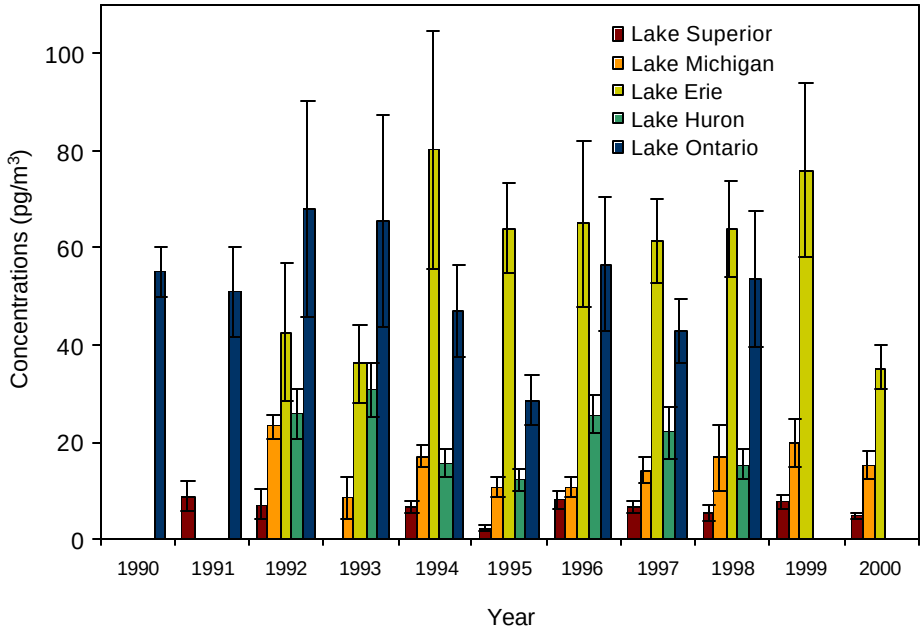

Figure 9-A4. Annual Average Particle-phase B(a)P Concentrations

Concentrations of B(a)P, on the other hand, show no real trend up or down (see Figure 9-A4). B(a)P concentrations are higher near major population centers (Lake Erie and Lake Ontario stations). Concentrations in Chicago (not shown) are about 1-2 orders of magnitude higher than concentrations at the IADN master stations.

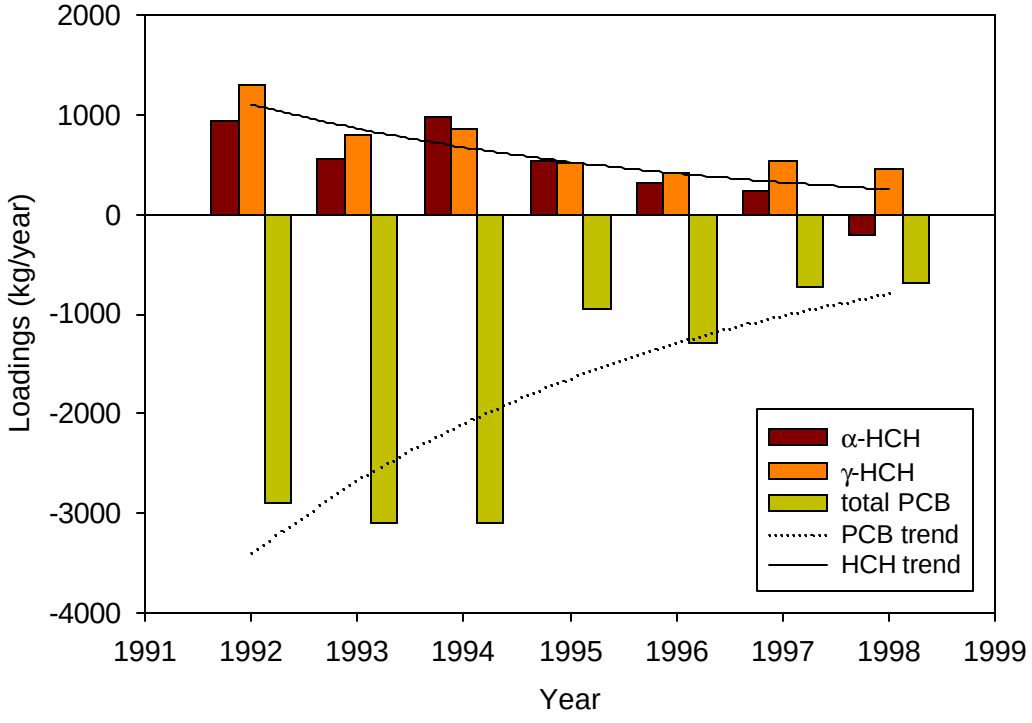

Figure 9-A5. PCB and HCH Loadings to the Great Lakes Basin

An atmospheric loading is the amount of a pollutant entering a lake from the air through precipitation, falling particles, and gaseous absorption into the water, minus the volatilization of the pollutant out of the water column. Figure 9-A5 shows total basinwide loadings for a-HCH, ?-HCH (lindane), and total PCBs from the five master stations. A bar pointing down indicates that the net loading is negative and the compound is volatilizing into the atmosphere. On a basinwide scale, the absolute values of the loadings are generally getting smaller, which indicates that the lake water and the air above it are moving closer to being in equilibrium.

National Air Pollution Surveillance (NAPS) Network

Through the National Air Pollution Surveillance (NAPS) network, data are collected on ambient air levels for a variety of toxics at rural, suburban, city-centre, and industrial sites in Canada. This effort is carried out in cooperation with provincial environmental and municipal agencies. The program includes measurement of volatile organic compounds (VOC), including toxics and ground-level ozone precursors, polar volatile organics (PVOC) such as aldehydes and ethers, components of fine particulate matter (PM), including metals and inorganic and organic ions, and persistent, toxic semi-volatile organic compounds (SVOC) such as benzo(a)pyrene and polychlorinated dibenzo-p-dioxins (CDDs) and furans (CDFs). One of the purposes of the monitoring effort is to provide data on trends in air concentrations of toxics and thus measure the success of initiatives carried out under the Toxic Substances Management Policy (TSMP) and under the Canada-Ontario Agreement (COA) respecting the Great Lakes Basin ecosystem.

Some examples of trends in selected species are shown in Figures 9-A6 to 9-A10. The box plots show median, 25th and 75th percentiles, and non-outlier minimum and maximum. In some cases outliers and extremes are also provided.

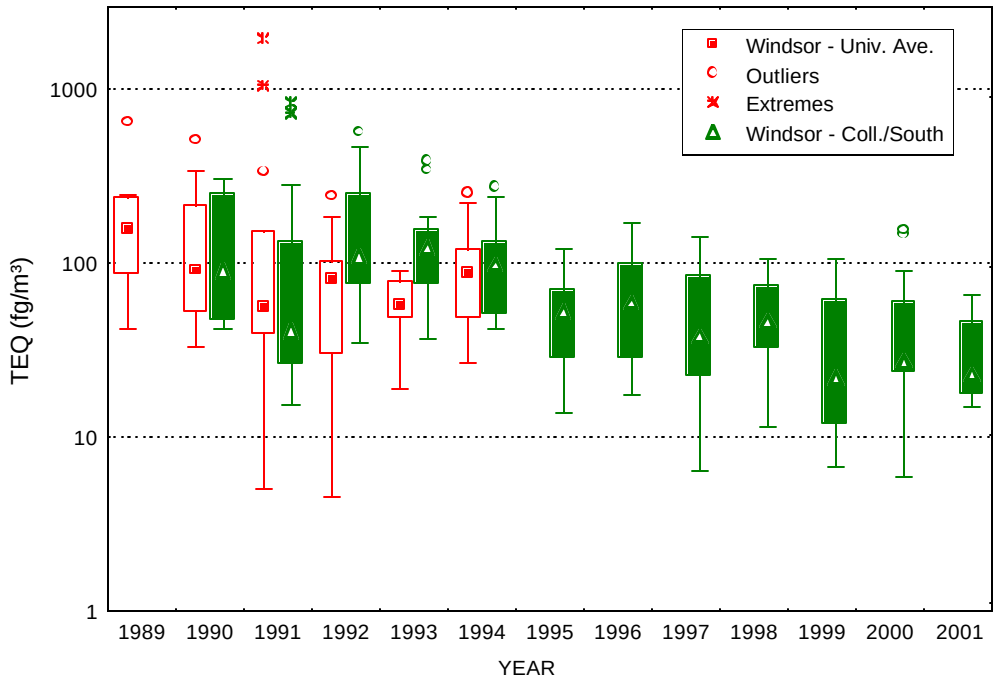

Figure 9-A6. Trend in 2,3,7,8-TCDD Toxic Equivalents (fg/m³) at Windsor, Ontario (1989-2001)

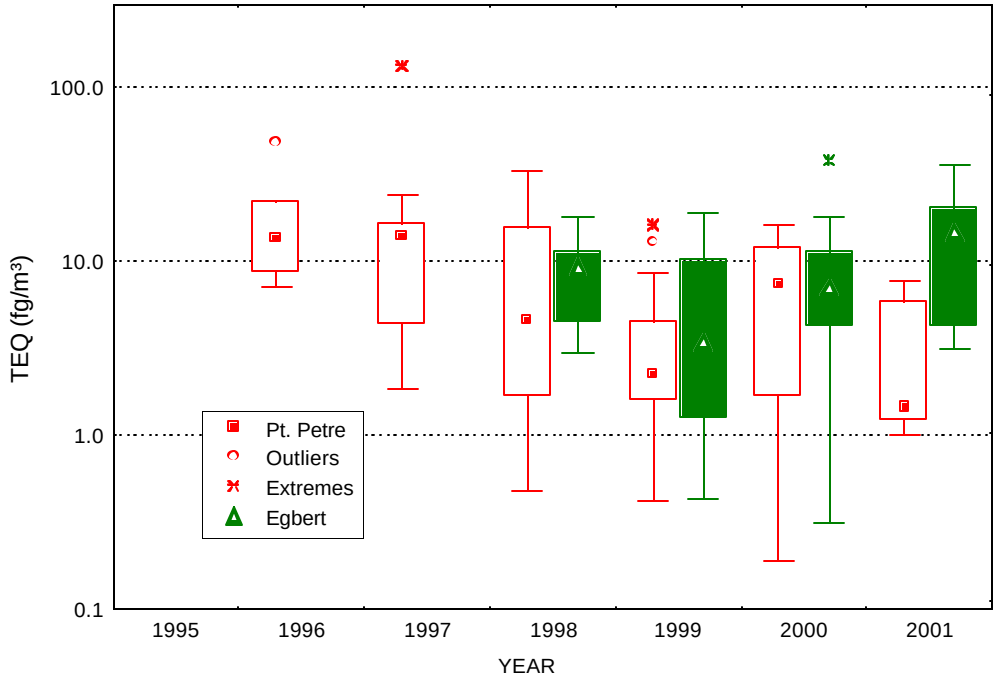

Figure 9-A7. Trend in 2,3,7,8-TCDD Toxic Equivalents (fg/m³) at Two Rural Ontario Sites (1995-2001)

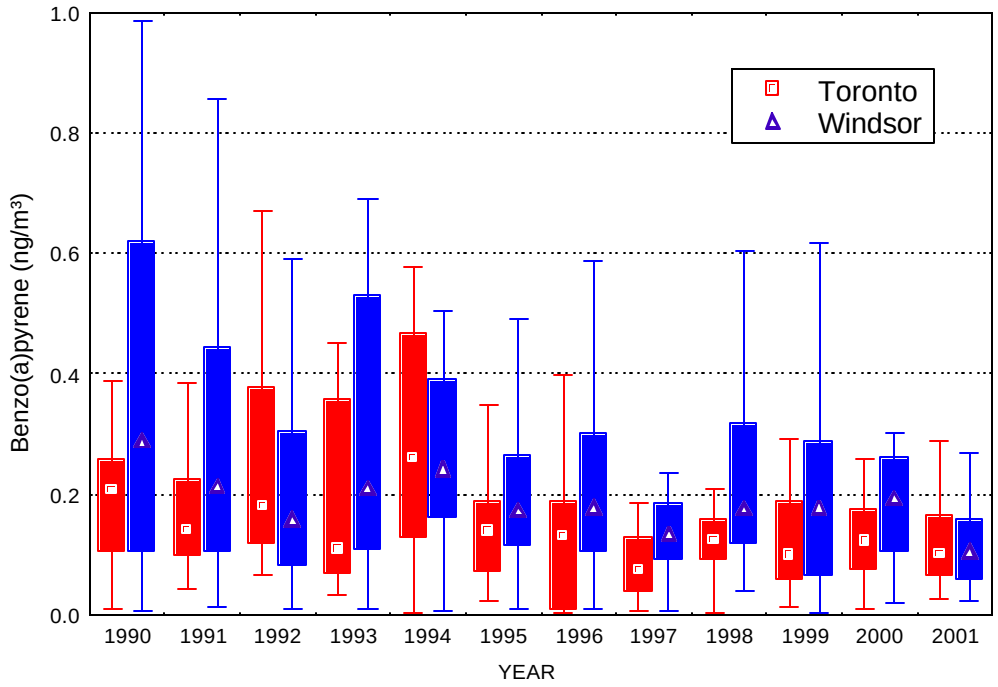

Figure 9-A8. Trend in Benzo(a)pyrene Concentrations (ng/m³) at Urban Sites (1990-2001)

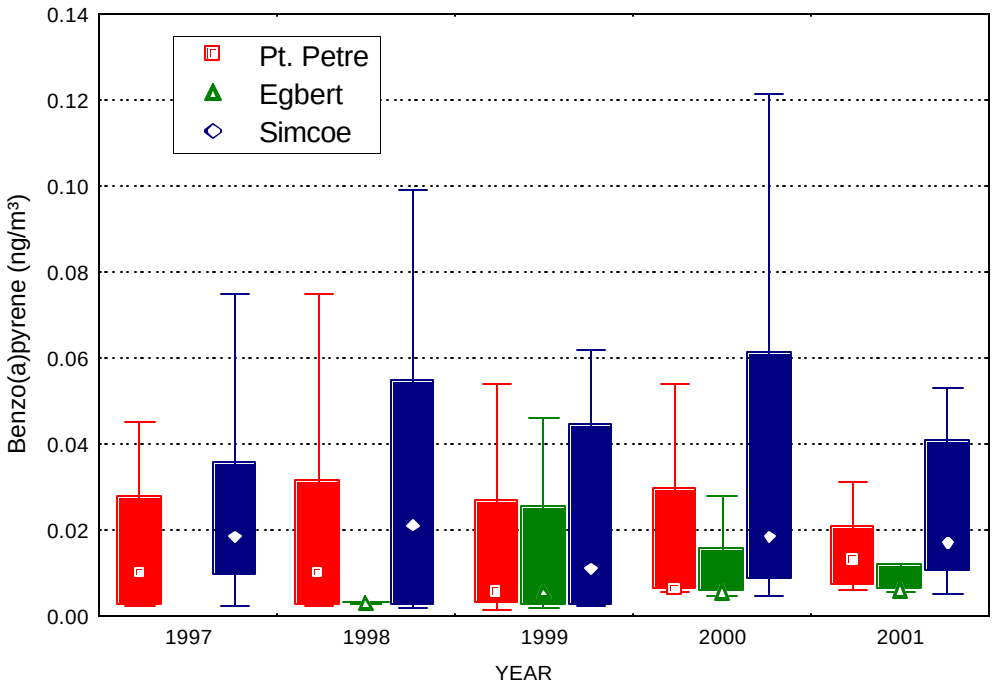

Figure 9-A9. Trend in Benzo(a)pyrene Concentrations (ng/m³) at Rural Sites (1997-2001)

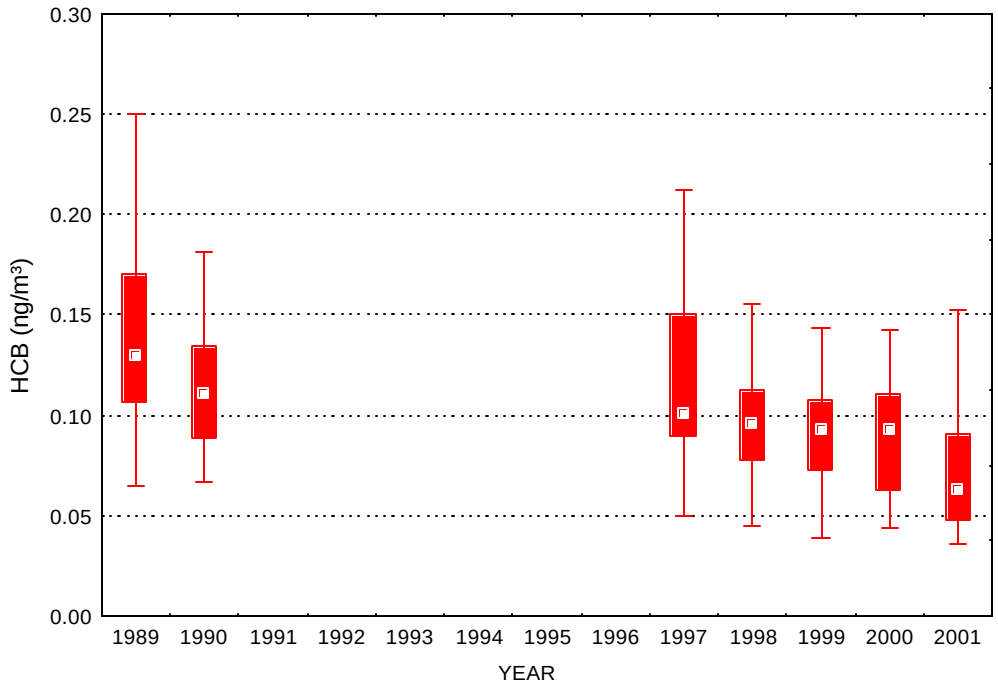

Figure 9-A10. Trend in Hexachlorobenzene Concentrations (ng/m³) at Windsor, Ontario (1989-2001)

Canadian Atmospheric Mercury Measurement Network (CAMNet)

In 1996, Environment Canada initiated the Canadian Atmospheric Mercury Measurement Network (CAMNet) to provide a better understanding of mercury trends and processes in the environment. Currently, there are four stations in Ontario (three at IADN stations and one on a buoy in Lake Ontario). CAMNet stations measure total gaseous mercury (TGM), mercury in precipitation, and reactive gaseous mercury and particulate mercury (though NOT all parameters are measured at each station). Figure 9-A11 illustrates that concentrations of TGM have remained relatively stable between 1997 and 2000.

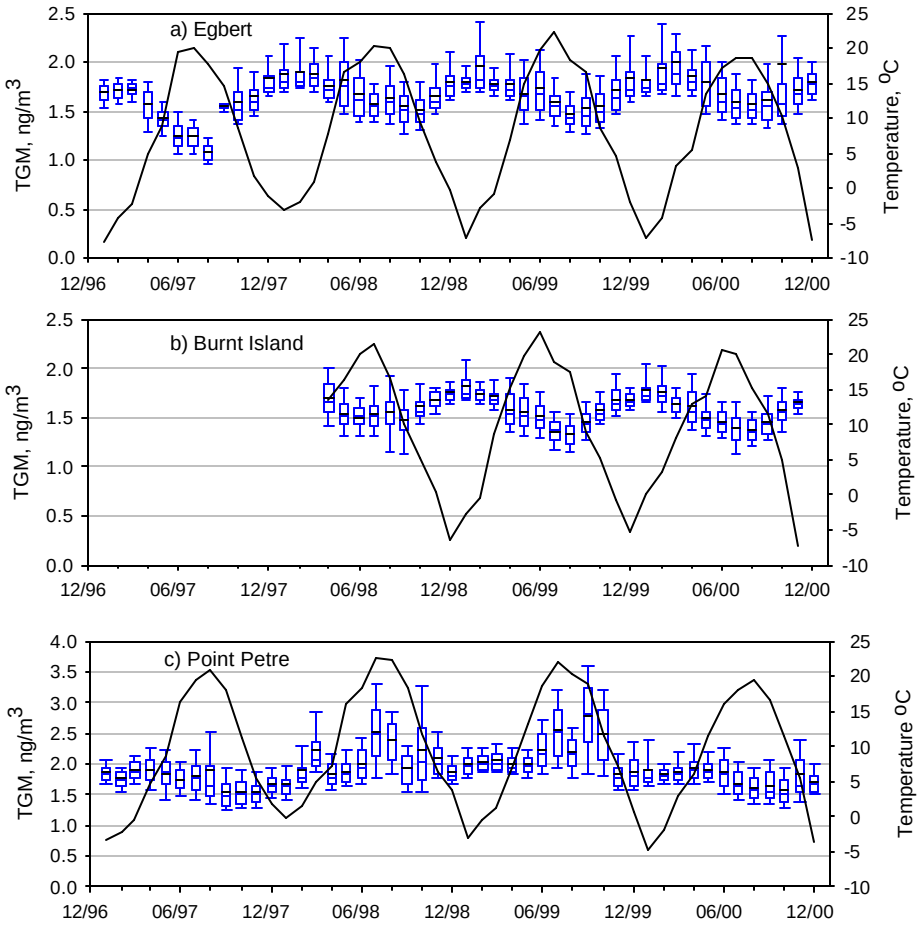

Figure 9-A11. Monthly TGM and Temperature Means at Canadian IADN Stations

Mercury Deposition Network (MDN)

Another very important North American monitoring network is the Mercury Deposition Network (MDN), which is part of the National Atmospheric Deposition Program (NADP). This program began monitoring pH and major inorganic ions related to "acid rain" in the U.S. in 1978. In 1995, NADP began an experimental monitoring program for wet deposition of mercury, the MDN. This program has grown into an international network with over 75 sites in the U.S. and Canada (see Figure 9-A12). NADP will soon be participating in a new acid rain and mercury wet deposition monitoring program in Mexico starting in 2003. MDN collects weekly precipitation samples at sites in the U.S. and Canada and analyzes them for total mercury. At the option of the sponsoring agency, samples from some of the sites are also analyzed for methylmercury. With many of the MDN sites being established in the last few years, it is too early to discern national spatial or long-term temporal trends.

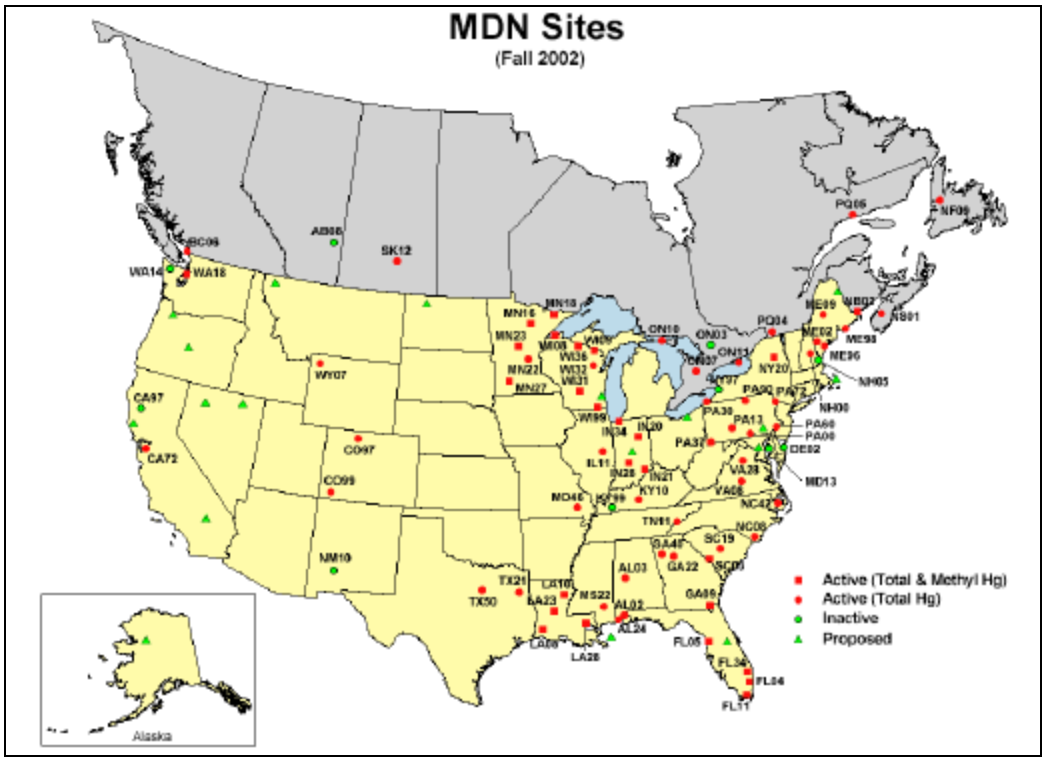

Figure 9-A12. The Mercury Deposition Network (Fall 2002)

National Dioxin Air Monitoring Network (NDAMN)

In June 1998, US EPA established the National Dioxin Air Monitoring Network (NDAMN). The primary goal of NDAMN is determine the temporal and geographical variability of atmospheric CDDs, CDFs, and coplanar PCBs at rural and nonimpacted locations throughout the U.S. Currently operating at 32 sampling stations (Figure 9-A13), NDAMN has three primary purposes: (1) to determine the atmospheric levels and occurrences of dioxin-like compounds in rural and agricultural areas where livestock, poultry and animal feed crops are grown; (2) to provide measurements of atmospheric levels of dioxin-like compounds in different geographic regions of the U.S.; and (3) to provide information regarding the long-range transport of dioxin-like compounds in air over the U.S. Sampling proceeded with a regime of sampling 24 days, every other month. This produced four sampling moments over the 12 months: (1) January/February, (2) April/May, (3) August/September, and (4) November/December. Although not perfectly aligned with seasons, such a scheme has encompassed different climatic conditions.

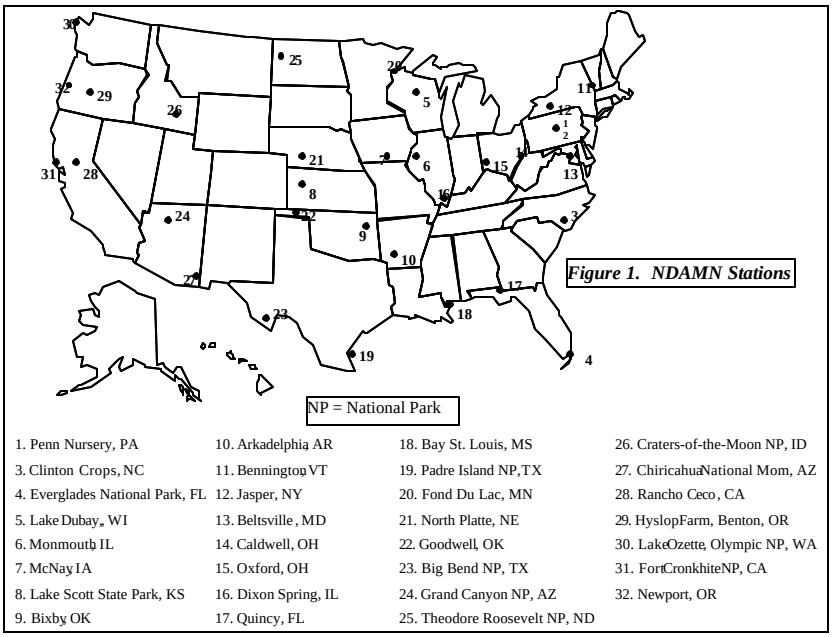

Figure 9-A13. Locations of NDAMN Stations in the U.S.

Figure 9-A14 is a summary of annual average ambient air concentrations of dioxin (expressed as TEQ or Toxic Equivalence to 2,3,7,8-TCDD) and dioxin-like PCBs (expressed as TEQ) collected at all rural NDAMN locations operating in the year 2000. These data suggest that atmospheric dioxin concentrations in the southern, western, and eastern Great Lakes States are somewhat higher than in other parts of the country. This may be a reflection of the population density and locations of certain heavy industries and incineration sources within urban areas.

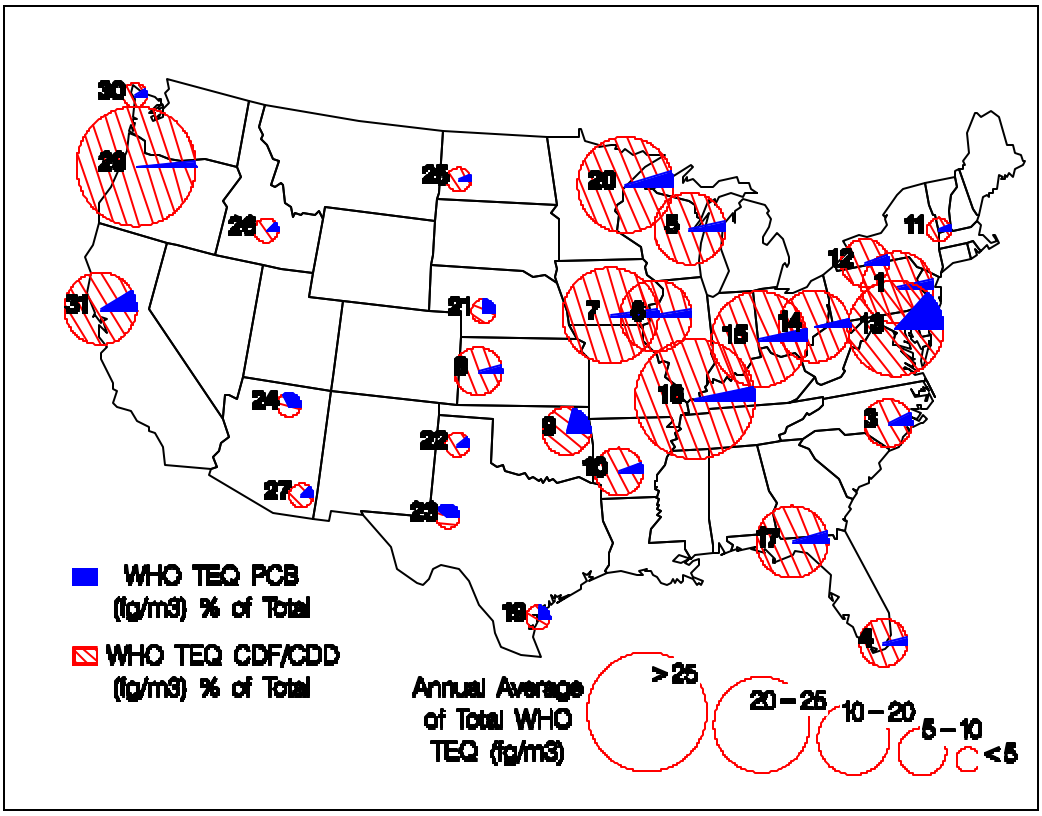

Figure 9-A14. Average Atmospheric Concentrations of Dioxin TEQ (from PCDDs, PCDFs, and Coplanar PCBs) in femtograms (10-15 grams) per cubic meter for the Year 2000, Collected by the National Dioxin Air Monitoring Network (NDAMN)

Acknowledgements

Todd Nettesheim of the US EPA Great Lakes National Program Office coordinated this section of the report. The work of the IADN Steering Committee heavily contributed to the IADN section, with Stephanie Buehler, Ron Hites, and Ilora Basu of Indiana University contributing figures. Tom Dann of Environment Canada provided the summary and figures for the NAPS section. Pierrette Blanchard of Environment Canada reviewed the CAMNet section and contributed a figure. Clyde Sweet of the Illinois State Water Survey contributed text and figures for the MDN section. David Cleverly of the US EPA Office of Research and Development contributed text and figures for the NDAMN section. Melissa Hulting of the US EPA Great Lakes National Program Office also reviewed this section of the report.

For Additional Information

The IADN website: http://www.msc.ec.gc.ca/iadn/

Great Lakes National Program Office Environmental Indicators:
http://www.epa.gov/grtlakes/glindicators/air.html

The National Air Pollution Surveillance (NAPS) Network: http://www.etcentre.org/naps/

The Canadian Atmospheric Mercury Network website: http://www.msc-smc.ec.gc.ca/arqp/camnet_e.cfm

The Mercury Deposition Network website: http://nadp.sws.uiuc.edu/mdn/

The National Dioxin Air Monitoring Network: http://www.epa.gov/ncea/pdfs/dioxin/dei/NDAMN_PAPER3a.pdf

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